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The Directors

OF

The Rockefeller Institute for Medical Research

WILLIAM H. WELCH, M.D.

T. MITCHELL PRUDDEN, M.D.

L. EMMETT HOLT, M.D.

CHRISTIAN A. HERTER, M.D.

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84930

Description of the Buildings

OF

The Rockefeller Institute for Medical Research

DESCRIPTION OF THE BUILDINGS OF THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH.

THE Rockefeller Institute for Medical Research embraces, at the present time, three independent buildings: the laboratory building, the animal house, and the power house. The buildings, which are constructed of steel and yellow brick with limestone trimmings, are fireproof, with the exception of the animal house, which is of semi-fireproof construction (see frontispiece).

The buildings are located on the eastern shore of Manhattan Island, at Sixty-sixth Street and Avenue A, and are situated upon a high, rocky bluff, fifty feet above tide water, overlooking on the one side the East River, and on the other side, the city to the west. From its favorable location in the midst of a large free area of three city blocks and its proximity to the East River, the Institute has unobstructed light in all directions; and since it stands over 325 feet beyond the line of Avenue A, it enjoys a remarkable immunity from the noises and commotion of city traffic.

The laboratory building, the dimensions of which are 136 by 60 feet, faces west and consists of a basement, five full stories, and it carries upon the roof an independent structure for housing animals, to which are attached out-of-door runs for the animals, suites of rooms for surgical operations, and a room for post-mortem examinations.

The basement, which is half above ground, is well lighted with windows. It is paved with concrete and contains a series of rooms which are devoted to a variety of purposes. Several of the rooms are given over to the

machinery of the building, such as the refrigeration and filtration plants, hot water tank, steam traps and reduced pressure valves, vacuum pump for supplying negative pressure throughout the laboratories, and intake of filtered air for ventilation. A large room has been provided here for the heavier apparatus used for general laboratory purposes, such as centrifuge, shaking apparatus, steam evaporation basins, etc. Other rooms are used for storage, from which are issued the laboratory supplies; for machinists' and carpenters' shop, and living quarters for the janitor.

The first floor of the laboratory building is devoted to administration, and contains also the library, assembly room, and a room for the Board of Directors (Plate XI). The provision for a library embraces four rooms: a large room 20 by 40 feet which contains the larger part of the books and which is also adapted for a reading room (Plate I); a smaller journal reading room in which the last numbers of current journals are made easily accessible; a small reading room in which is placed the cabinet containing the unbound current numbers of journals; and a cataloguing room. The assembly room is rectangular in shape and has a seating capacity of about one hundred. It is fitted with a blackboard, screen and platform for a lantern, and outlets for steam, vacuum, hot and cold water, and electricity, for use in demonstrations. Adjacent to and in communication with the assembly room is a small preparation room in which experiments are arranged for demonstration.

The second floor is fitted as a chemical laboratory, and is divided into small and large rooms for general laboratories for the workers, and rooms in which particular chemical operations are carried out (Plate XI). The general laboratories occupy the western (Plate II) and the special rooms, the eastern side of the building. Adjacent to the

laboratories occupied by the workers are the balance and spectroscope rooms.

Several rooms with impervious concrete floors have been provided for the purpose of preparations, machinery, etc. The mechanical room, the dimensions of which are 22 by 24 feet, contains a hydraulic pump for maintaining a high, constant, negative pressure for filtration purposes; a double cylinder Geryk pump for securing high degrees of vacuum; steam distillation outfits for water and alcohol; apparatus for drying in an air current at low temperatures; Buchner press; etc. Located at a convenient position to be readily accessible to all workers on this floor is the refrigeration room (see below).

The third floor of the building is used as laboratories of experimental pathology (Plate XI). The southern end of the floor is occupied by a suite of rooms for operations on animals under aseptic conditions. The suite consists of an ante-room which contains a bath tub and drying cage. The bath is intended for dogs chiefly, but is large enough for a sheep or goat.

The drying cage is of galvanized iron and measures 3 by 6 by 3 feet, and is connected with a one-fourth horse-power motor and blower for drawing a current of air over steam coils and driving it into the cage. The angle of entrance and the force of the current cause the heated air to circulate throughout the cage (Plate III). The adjoining or middle room of the suite is for sterilization and preparation of instruments, etc., and the inner room forms the operating room proper. High pressure steam connections are provided in the sterilization room, and all the sterilization of dressings and instruments can be readily carried out under pressure in an autoclave.

Attached to this suite is a larger room, 21 by 24 feet, provided with a concrete floor, which is used as a hospital

for animals under observation. The hospital is fitted with cages for dogs and other small animals, which it is desired to keep under close inspection (Plate IV). This series of four rooms is provided with a special corridor and is separated by it from the main hall. This means of isolation suffices to exclude any objectionable odor or sound from the rest of the building.

The northern end of the floor is occupied by the director's study and laboratories (Plate V), and adjoining the director's study is an office for a secretary. The remainder of the floor is divided into small and large laboratories for individual research workers and groups of workers. The general laboratory has the dimensions 23 by 30 feet and will accommodate five or six workers.

A hot air thermostat, supplementing the individual thermostats scattered through the building, occupies one end of the room, providing a large space for the needs of the workers of this and other floors. In construction it is a laced double-walled room with an air space of about three inches. The outer wall is of oak, the inner of white wood. Heat is obtained from a gas stove and regulation from a Roux bi-metallic regulator. The excess of hot air is conducted from the stove to a flue by means of a small metal pipe which is first carried along the sides of the room to economize the heat. This hot room suffices for cultivating microorganisms and for digestion experiments, at temperatures ranging from 35° to 39° Centigrade, depending on the level at which they are placed. A technician's and cleaners' room adjoins the large laboratory.

The fourth floor is designed for work in bacteriology and animal parasitology, and in pharmacology and experimental therapeutics (Plate XII). With the exception of the rooms to be described, the space is given to laboratories for individual workers or groups of workers. Two rooms

have been constructed and arranged for the preparation of all culture media, for the cleansing of glass apparatus used in bacteriological work, etc. (Plate VI), and carrying out the larger part of the hot air and steam sterilization. These rooms are supplied with modern steam and hot air sterilizers, autoclaves, and steam boilers, the last being used for the sterilization of all apparatus used in the bacteriological studies. High pressure steam is available for sterilization purposes. Adjacent to the main preparation room is a smaller room, with a concrete floor, designed as a common operating room for this floor, for operations not requiring rigid aseptic technique, but in which are placed at present the smaller electric centrifuges.

The fifth floor contains the photographic suite (Plate XII), lunch room, kitchen, and living suite for workers who may be compelled, by their work, to spend the night at the laboratory; several rooms devoted, at present, to special purposes, and an unassigned space for future growth and development.

The photographic suite consists of a large general studio (Plate VII), a smaller room for microphotography (Plate VIII), a room for keeping the records, and a room for the storing of negatives. Adjacent to the microphotographical and general photographic rooms is the dark room which is entered through a winding passage with black walls which excludes daylight and obviates the need for a door. The dark room has been supplied with a connection from the refrigeration plant to make possible the cooling of the water in the large washing tank during the hot summer months.

A small room on this floor contains special forms of incubators,—for different temperatures and for cultivations in gelatin during the summer months. For cultivating large quantities of bacteria a Vaughan incubator has also been installed here.

The eastern side of this floor is occupied by a dining room which is used as a lunch room by the staff of the Institute, a kitchen communicating with the dining room, and the living suite consisting of a bed room and bath room.

On the roof of the laboratory building an independent house has been constructed of iron covered with copper. This house has been subdivided into rooms in which the dogs are housed, outside runs, communicating with these rooms, in which the dogs may run freely during the day, an autopsy room, and at each extremity, a suite of operating rooms. The main fans for the ventilating system also occupy a room in this house. The dog rooms extend along the east side of the roof; but a special isolated room has been placed on the west side (Plate XII). The rooms measure 9 by 13 feet and the adjoining runs, the floors of which are tiled, are separated from each other by high fences of heavy wire network, and each has an area of 100 square feet.

The operating rooms are arranged on the same general plan as the suite on the third floor. The anterooms are supplied with baths and drying cages. The operating room proper of the southern suite has, however, been constructed largely of glass. A skylight comprising 150 square feet of surface, looking to the north provides an abundance of daylight (Plate IX). The northern operating suite is completely isolated so as to be available for work upon special infective material.

The refrigeration plant is located in the basement of the laboratory building and supplies refrigeration to a series of refrigerators located one above the other on the different floors. These refrigerators measure 3 by 6 by 9 feet high and are subdivided, according to the purposes they are to serve. The refrigerator situated in the basement, which is intended for cold storage purposes has not been subdivided.

Its sides are fitted with wooden racks or shelves. The refrigerators on the second, third, and fourth floors are divided each into nine compartments in three tiers, each compartment has, therefore, dimensions of 2 by 3 by 3 feet deep. The system of refrigeration allows each tier to be regulated independently of the other tiers so that different degrees of temperature may be obtained in each series. The refrigerator on the fifth floor is located in the kitchen and is not divided into tiers. Like the one in the basement it is arranged for one constant temperature, and is fitted up with wooden racks for storage.

Refrigeration is obtained by the circulation of calcium brine through the refrigerators, the brine being cooled by the use of ammonia gas in a machine of the absorption type.

All the water used in the buildings is filtered through a series of four Loomis-Manning filters, containing a mixture of charcoal, shells, and sand. The coarser impurities are effectually removed and clear water is supplied in abundant quantity.

The laboratory building is ventilated by means of the "Fan Plenum" system. Fresh air is drawn from without through a series of canvas bags which retain the dust, and is passed over steam heated coils by means of an electric blower located in the basement. This air is discharged through a system of ducts into the different rooms, the quantity entering being regulated by adjusting the registers. The foul air is withdrawn through registers which are connected with two electric blowers situated on the roof: one of the blowers exhausting the air from the laboratories proper; and the other from the toilet rooms and hoods. The blowers may be operated independently of each other. The laboratories throughout the building are fitted with hoods containing hot and cold water, gas, vacuum, and electrical connections; the hoods on the second

floor being supplied, in addition, with steam under reduced high pressure.

The laboratory building is equipped with an Otis elevator of the latest design, having a capacity of 2,500 pounds.

A system of twenty-two intercommunicating telephones has been installed throughout the laboratories, and animal and power houses.

The animal house is a two-story building and provides for the keeping of all animals except dogs (Plate XIII). The lower floor is divided into a stable for horses, a stable for sheep and goats, a room for monkeys and snakes, this room being maintained at an even temperature in winter by a thermostat attachment to the steam-heating system; a large room for the stock of guinea-pigs and rabbits, and a smaller room for the stock of rats and mice. The second floor consists of a room for birds, a breeding room for guinea-pigs, a frog room, a fresh water aquarium, and a loft for the storage of grain.

A covered passage which communicates with the basement of the laboratory building connects the latter with the animal house. This covered way serves at the same time as a tunnel for the water, heating, and lighting conduits (Plate X).

The power house contains three sixty-five horse power boilers which generate the steam for the heating of the buildings, for operating the pumps, and for the sterilizers, steam baths, etc., distributed through the laboratories. It has a bunker capacity of 150 tons of coal. In a separate room in the power house is located a Morse-Bougler coal-burning destructor for crematory purposes, the dimensions of which are 3 by 7 by 4 feet high. This room also contains a concrete vat for the steaming of infected carcasses prior to their cremation.

Addresses

Delivered at the Opening of the Laboratories in New York City

May 11, 1906

A SKETCH OF THE DEVELOPMENT OF THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH.

By LUTHER EMMETT HOLT, M.D.,
Secretary of the Board of Directors.

Five years ago there were in France, Germany, England, Russia and Japan well-equipped and endowed institutions for research in medicine. In this country not one existed. For pure and applied science, all our higher institutions of learning had their laboratories, their corps of instructors and fellowships, and both opportunity and encouragement were given to students to take up original work. But how great the contrast when we turn to medicine, whose problems are related not only to the health but even to the life of the race. The poverty of the resources of the medical institutions was truly pitiful. Their laboratories were for the instruction of students and possessed but little equipment beyond what was necessary for this end.

It was at this time that a group of five men met in the Arlington Hotel at Washington just five years ago last week, at the request of the founder of this Institute, to consider the question of the establishment of an institution to promote research in medicine. There could be but one opinion, and, at the conference only one was expressed, *viz.*, That the most urgent need existed and that the time was ripe for the foundation of such an institution in this country.

Never was a suggestion more warmly welcomed nor an offer more heartily appreciated by the profession and the medical press from one end of the country to the other.

To this group of five, two others were added a few

weeks later, and on June 14, 1901, the institution was formally incorporated as The Rockefeller Institute for Medical Research, with the seven men referred to as its board of directors. They were William H. Welch, T. Mitchell Prudden, Christian A. Herter, Theobald Smith, Hermann M. Biggs, Simon Flexner and L. Emmett Holt. The same board has been continued up to the present time. At this first meeting a pledge of $200,000 was made to the board to be drawn upon at their discretion during a period of ten years, it being understood that this was for preliminary work.

In considering what use should be made of the funds placed at its disposal to make them immediately productive of some scientific results, and at the same time to get a general view of the field, the board decided not to centralize work in a single place, but to create a number of scholarships or fellowships to be distributed in existing laboratories throughout the country. In this way it was hoped that several ends might be attained: first, to enlist the coöperation of various investigators in different places; secondly, to aid some promising lines of research which could not be continued for lack of funds; and, finally, to discover who and where were the persons who desired to undertake research work and what were their qualifications.

From a large number of applications received, twenty-three grants were made to eighteen different laboratories in this country, and three men were sent abroad to pursue special investigations, two in Ehrlich's laboratory in Frankfurt and one in Koch's Institute in Berlin.

At the end of the first year's work, it was evident to the directors that while much could be accomplished by individual workers carrying on their investigations in separate laboratories, widely scattered, the highest results in research could not be secured in this manner. Existing institutions

did not afford adequate facilities for many phases of investigation which were of the greatest importance. Again, the heads of these institutions, although in many instances men of great ability, were so taken up with their duties as teachers as to leave compartively little either of time or energy to devote to research work. It was gratifying to find that there were a large number of earnest men and women in America anxious to devote themselves to this branch of science; but it was quite clear that very few possessed the breadth of education combined with the technical training requisite for independent work.

The directors, therefore, were united in the conviction that, although many important investigations might be fostered by continuing the plan of foreign grants, great progress was not possible in this way, and that this could be secured only by centralizing the most important lines of work in a fixed place, under a competent head or series of heads, and with special equipment. In other words, the Institute must have a laboratory of its own with its own staff of workers who should devote their entire time to research.

These conclusions and the considerations upon which they were based were, therefore, placed before the founder, who at the second annual meeting, in June, 1902, made another and larger gift to the Institute, to enable the board of directors to acquire land and erect a laboratory building in which to begin the work of organization along the broader lines contemplated.

The first question to be decided was where such an institute should be located. After due consideration of the advantages offered in other cities, New York was unanimously selected as possessing greater advantages than were elsewhere to be found in America. The next step was to find a suitable site; one which should be adequate, not only

to present needs, but for future expansion; near enough to the center of the city to be accessible, and yet sufficiently removed to secure for its workers the freedom from needless interruptions and the quiet necessary for scientific pursuits.

After a prolonged search, the committee on site reported in October, 1902, in favor of the Schermerhorn property, fronting East River at East 66th and 67th Streets, as meeting to a remarkable degree all the requirements. This entire property was purchased by Mr. Rockefeller a few months later, and a plot comprising twenty-six and one half city lots, upon which the present building stands, was deeded to the Institute. Work was immediately begun upon plans for a laboratory building.

The next great question was the choice of a scientific director. After looking over the entire field in America and Europe, the board could find no one possessing the qualifications to so high a degree as one of its own members, Dr. Simon Flexner, who was prevailed upon to resign his position as professor of pathology in the University of Pennsylvania, and assume the directorship of the scientific work in the new laboratory. Dr. Flexner began his work July 1, 1903, and spent the following year in Europe, studying various questions connected with institutions for research, especially those of organization, construction and equipment. He also acquired the nucleus of a library for the Institute.

Eighteen months and much careful thought were spent in completing the plans for the present laboratory building. During this time five of the directors visited Europe, in order to profit by the experience of other institutions of a similar character. Final plans were adopted June 13, 1904; and a few weeks later contracts were let, ground was broken for the new building and December 3 of the same year the cornerstone was laid.

It was quite clear to the directors that it was unwise to delay commencing work until the new laboratory was completed. It was decided to take steps at once to get together a nucleus of a future laboratory staff; that it was best that a beginning should be made with a small program, a few problems, in a small building, so that the Institute should be in a position for a natural organic growth and development and avoid the dangers incident to rapid expansion. A building at the corner of Lexington Avenue and 50th Street was leased and fitted up for temporary use. In that place, in October, 1904, work was begun and continued for eighteen months until the completion of the new building a few weeks ago.

The staff at first consisted only of the director and four other workers. It has, however, been gradually increased until, at the time of removal, it numbered nine persons.

One of the most difficult problems presented to the board has been to secure a staff of scientific workers. Heads of laboratories and their assistants in this country are, almost without exception, men trained for the work of instruction rather than that of investigation. Many applications for positions in the Institute have been received from England, France and Germany, but it has been the policy of the board of directors up to the present to make appointments upon the staff of the Institute chiefly from American sources. Many young men and women were found in this country with evident capacity, yet few possessed necessary training which should fit them to work independently. With each year's experience the conviction has steadily grown that the Institute must in large measure train its own staff, selecting from the promising young applicants such as give evidence of special fitness and giving them subsequently such training both here and abroad as would fit them for their special work.

To get in close touch with such a class, a number of resident scholarships and fellowships have been created. For these thirty-one applications were received during the present year and five have been awarded. This plan, if successful, will be continued and from this corps, from time to time, will be recruited the future workers of the Institute.

The present organization provides for the following departments: pathology, bacteriology, physiological and pathological chemistry, physiology, comparative zoölogy. To these it is expected that a department of pharmacology and experimental therapeutics will soon be added.

The fully organized staff will consist of a chief director and a head for each of the different departments. Each head will have his associate and corps of assistants. The heads of departments, associates and first assistants, it is expected, will constitute the permanent staff of the Institute. The other workers will be less closely attached. Besides, there are contemplated scholarships and fellowships for workers who may come for a limited period; and finally, it is expected to provide for a limited number of voluntary workers who will be given the facilities of the Institute for working out, under supervision, their own problems.

While the purpose of the Institute will be research, not instruction, it cannot fail to exert a considerable influence upon medical education, since many of those who will receive their training within its walls will, doubtless, go elsewhere to assume positions of responsibility as teachers or investigators.

The present scientific staff consists of fourteen persons; the laboratory building, when fully equipped, will furnish facilities for about fifty workers.

Much work must always be done in the fundamental subjects of chemistry, biology, physiology and pathology,

for upon these basic sciences future discoveries in medical science must largely rest. While fully realizing the importance of these and liberally providing for them in its laboratory, the Institute aims at the same time to keep close to the practical side, and will endeavor to apply the latest discoveries in science to problems connected with the prevention and cure of disease. In order that the greatest good can be accomplished along these lines, the board realizes that a hospital closely affiliated with the Institute is indispensable. Only in this way is it possible for those who work in the laboratory to appreciate the relation of their results to the problems of practical medicine. The hospital need not be large, but should be fully equipped. Such a hospital it is hoped may soon be added to the Institute, in which the closest kind of scientific study may be given to obscure pathological conditions.

From the very beginning, the Institute has sought not to monopolize the field, but to coöperate in all possible ways with existing agencies for medical research in this country. It has coöperated with the Health Department of New York in the study of the conditions surrounding the production and distribution of the milk supply of the city, and the effects of milk upon the health of the children in the tenements; also with the commission appointed by the city in 1904, to study the prevalence of the acute respiratory diseases, and with that appointed in 1905 to investigate cerebro-spinal meningitis. It has united with Harvard University in sending men to Manila to study certain phases of smallpox. With the same end in view, also, it has made grants each year to assist important investigations which were being carried on in various places.

While it has been impossible to aid more than a small proportion even of the suitable cases asking for assistance, still an average of twenty grants has been made each year,

and much excellent work done which otherwise could not have been undertaken.

With the opening of a central laboratory for research in New York, these foreign grants will necessarily become a less important part of the work. It is not, however, the intention of the Institute to discontinue them altogether. The board hopes always to be ready, with a grant of money or by sending a trained man, to assist in the solution of any important emergency problem which may arise in connection with the public health in any part of the country.

The work done entirely or in part under the auspices of the Institute and published in various scientific journals has been collected in volumes of reprints; four such volumes of about five hundred pages each have already been issued, two in 1904 and two in 1905; a fifth volume is now in press. The need of a special organ of publication was early felt by the board and in 1904 negotiations were opened with the editor of *The Journal of Experimental Medicine* with a view to transferring its control to the Institute. This has been accomplished.

In February, 1905, the Institute took charge of the publication of this journal, under whose auspices it has since been issued. In it are published not only the work of the Institute, but also other scientific contributions of a similar nature.

In the five volumes of reprints appear 137 original papers; they may be classified under the following heads: There are 50 papers relating to etiology, or the causation of disease; 28 relating to pathology; 12 to bacteriology; 22 to physiology; 8 to chemistry; 9 to toxicology; 7 to experimental therapeutics, and 1 to pathological anatomy.

Among the most important researches in point of the attention which has been given to them may be mentioned: 21 papers upon dysentery and diarrhœal diseases; 5 papers upon milk; 4 papers upon smallpox; 12 upon various patho-

logical conditions of the blood; 3 upon diabetes; 5 upon trypanosomiasis, and 6 upon snake venom. The other topics are widely distributed over the field of scientific medicine.

To many, five years may seem a long time to be taken up with the work of preliminary organization. Many difficulties have been encountered and many perplexing questions have come up for decision. It has been the policy of the board of directors to proceed deliberately, and no step has been taken until a conviction regarding its wisdom was practically unanimous.

To outline the development of an institution which should secure the highest possible efficiency has been no easy task. European models have aided greatly, but it was believed that what was needed in America was an institution different in many respects from those of Europe. While many years will be required for the full development of the Institute, the board has felt that the general policy should be reflected from the outset. Throughout it has striven to keep constantly in mind the intention of the founder, expressed in his letter of gift, that the trust was to be administered in such as way as 'to accomplish the most for humanity and science.'

The present staff of the Institute is composed of the following persons:

Department of Pathology and Bacteriology—Dr. Simon Flexner, Dr. E. L. Opie, Dr. H. Noguchi, Dr. J. E. Sweet, Dr. H. S. Houghton.

Department of Physiology—Dr. S. J. Meltzer, Dr. John Auer.

Department of Chemistry—Dr. P. A. Levene, Dr. W. A. Beatty.

Resident Fellows and Scholars—B. T. Terry, zoölogy; R. D. MacLaurin, chemistry; Chas. A. Rouiller, chemistry; E. H. Schorer, bacteriology; Bertha I. Barker, bacteriology.

THE BENEFITS OF THE ENDOWMENT OF MEDICAL RESEARCH.

By WILLIAM HENRY WELCH, M.D.,
President of the Board of Directors.

The support of hospitals has always made a strong appeal to the philanthropy of the state and of individual citizens, and the importance to the community of educated physicians has been appreciated, although in this country until recent years most inadequately, but the recognition of medical science as a rewarding object of public and private endowment is almost wholly the result of discoveries in this department of knowledge made during the last quarter of a century. An eloquent witness to the awakening of this enlightened and beneficent sentiment is the establishment, in 1901, of the Rockefeller Institute for Medical Research with its laboratories formally opened to-day.

While the scientific study of infectious disease is, of course, not of recent origin and had been pursued as a part of the functions of health departments and of university laboratories of hygiene and of pathology, the first provision of a special laboratory for this purpose was made by the German government in 1880, in the Imperial Health Office in Berlin, and to the directorship of this laboratory was called from his country practice Robert Koch, who four years before had startled the scientific world by his memorable investigation of anthrax.

The supremacy of Germany in science is due above all to its laboratories, and no more fruitful record of scientific discoveries within the same space of time can be found than that afforded by this laboratory during Koch's connection

with it from 1880 to 1885. Thence issued in rapid succession the description of those technical procedures which constitute the foundation of practical bacteriology and have been the chief instruments of all subsequent discoveries in this field, the determination of correct principles and methods of disinfection, and the announcement of such epochal discoveries as the causative germs of tuberculosis—doubtless the greatest discovery in this domain—of typhoid fever, diphtheria, cholera, with careful study of their properties.

The leading representative, however, of the independent laboratory devoted to medical science is the Pasteur Institute in Paris, founded in 1886, and opened in 1888. The circumstances which led to the foundation of this institute made probably a stronger appeal to popular sympathy and support than any others which have ever occurred in the history of medicine.

There stood in the first place the personality and the work of that great genius, Louis Pasteur, of noble and lovable character, one of the greatest benefactors of his kind the world has known, who for forty years had been engaged, often under adverse conditions, in investigations which combine the highest scientific interest with important industrial and humanitarian applications. Pasteur's revelation of the world of microscopic organisms in our environment—the air, the water and the soil—and his demonstration of their relation to the processes of fermentation and putrefaction had led Lister in the late sixties, even before anything was definitely known of the causative agency of bacteria in human diseases, to make the first and most important application of bacteriology to the prevention of disease by the introduction of the principles of antiseptic surgery, whereby untold thousands of human lives have been saved.

In 1880 came the most momentous of Pasteur's contributions to medical science and art in the introduction of the

method of active immunization by the use of the living parasites of the disease attenuated in virulence, a method which until this date had remained without further application since its employment by Edward Jenner in 1796 in vaccinating against smallpox. Pasteur's researches in this field of immunity, marvelous in their originality, ingenuity and fertility of resource, culminated in 1885 in the announcement of his successful method of protective inoculation against that dread disease, rabies, and most of those here present will recall the enthusiasm with which this great triumph of experimental medicine was hailed throughout the civilized world.

It was under the immediate impression and the incentive of this discovery, and as a mark of gratitude to Pasteur, that over two and one half million francs were raised within a short time by international subscription for the construction and endowment of an institute to bear his name, where the Pasteur treatment was to be carried out and ample facilities afforded for investigations of microorganisms and the problems of infectious diseases. This model institute, much enlarged since its foundation and after the death of Pasteur under the directorship, first of Duclaux, and now of Roux, and, in one of its most important divisions, of Metchnikoff, has been a fruitful center of productive research and through its contributions to knowledge affords a signal illustration of the benefits to science and to humanity of the endowment of laboratories for the advancement of medical science.

It was under much the same influences that the important Imperial Institute for Experimental Medicine in St. Petersburg, with even wider scope than the Pasteur Institute, was founded and munificently endowed by Prince Alexander of Oldenburg in 1890.

In the following year the Prussian government estab-

lished in Berlin, under the directorship of Professor Koch, the admirably organized and equipped Institute for Infectious Diseases, to which is attached, as to the Pasteur Institute, a hospital for infectious diseases. This and the excellent Institute for Experimental Therapeutics, in Frankfurt, under Professor Ehrlich's direction, founded also by the Prussian government in 1896, are unsurpassed in their scientific activities and in the number and value of their contributions to our knowledge of infection and immunity.

In 1891 was founded in London the British, later the Jenner, and now the Lister, Institute of Preventive Medicine, designed to be a national institute similar in character and purpose to the Institut Pasteur in Paris. The funds were contributed by the public and subsequently increased by Lord Iveagh's generous gift of two hundred and fifty thousand pounds.

Within less than a year after the foundation of the Rockefeller Institute for Medical Research the Memorial Institute for Infectious Diseases was founded in Chicago by Mr. and Mrs. Harold F. McCormick, and placed under the capable direction of Professor Hektoen.

The Institute for the Study, Treatment and Prevention of Tuberculosis, which bears the name of its beneficent founder, Henry Phipps, was incorporated in Philadelphia in 1903, and, while devoted to a single disease, it must be ranked among those of wide scope, when we consider the magnitude and surpassing importance of the problems pertaining to this disease.

It may also be noted that the Carnegie Institution of Washington, with its unequaled endowment of ten million dollars, includes within its scope the support of biological and chemical investigations of great importance to medical science, so that our country now stands in line with Germany, France and Great Britain in the opportunities afforded for research in medical and other sciences.

These various institutions have been mentioned as typifying the general aims and character of the Rockefeller Institute for Medical Research, rather than to afford any complete picture of the material aid now available for the advancement of scientific medicine. If the latter were the purpose, it would be necessary to travel far afield so as to include independent medical laboratories of more restricted scope, such as those for the study of cancer, the laboratories connected with departments of health, so well exemplified in our own country by those of the state board of health of Massachusetts, and of the department of health of the city of New York, hospitals and the laboratories connected with them, the medical laboratories of the universities and medical schools, such as the Thompson Yates and Johnston laboratories in Liverpool and the splendid new laboratories of the Harvard Medical School, laboratories established in recent years for the study of tropical diseases, such as our government laboratories in Manila, and funds available for special grants to investigators.

Impressive and encouraging as is this remarkable growth within recent years of laboratories devoted to the medical sciences, no one who has any knowledge of the vast field to be covered, of the difficulty and complexity of the problems, of the expenditure of money required, and of the returns in increased knowledge and benefits to mankind which have been attained and which may be expected in increasing measure, can for a moment suppose that the existing opportunities, considerable as they are, are adequate to meet the present and the future needs of scientific medicine.

As I have already stated, the wider recognition of medical science as a rewarding object of endowment is a result of discoveries made during the last quarter of a century,

and it is of interest to inquire why this increased knowledge should have borne such abundant fruit. The result is not due to any change in the ultimate aims of medicine, which have always been what they are to-day and will remain, the prevention and the cure of disease, nor to the application to the solution of medical problems of any higher intellectual ability and skill than were possessed by physicians of past generations, nor to the growth of the scientific spirit, nor to the mere fact of a great scientific advance in medicine, for the most important contribution ever made to our understanding of the processes of disease was the discovery by Virchow, in the middle of the last century, of the principles and facts of cellular pathology, the foundation of modern pathology.

The awakening of this wider public interest in scientific medicine is attributable mainly to the opening of new paths of investigation which have led to a deeper and more helpful insight into the nature and the modes of prevention of a group of diseases—the infectious diseases—which stand in a more definite and intimate relation to the social, moral and physical well-being of mankind than any other class of diseases. The problems of infection which have been solved, and kindred ones which give promise of solution, are among the most important relating to human society. The dangers arising from the spread of contagious and other infectious diseases threaten not the individual only but industrial life and the whole fabric of modern society. Not medicine only, but all the forces of society are needed to combat these dangers, and the agencies which furnish the knowledge and the weapons for this warfare are among the most powerful for the improvement of human society.

Great as was the material, intellectual and social progress of the world during the past century, there is no advance which compares in its influence upon the happiness

of mankind with the increased power to lessen physical suffering from disease and accident, and to control the spread of pestilential diseases. Were we to-day as helpless as the physicians of past centuries in the face of plague, smallpox, typhus fever, cholera, yellow fever and other epidemic disease, even if the existence of our modern crowded cities were possible, which may be doubted, the people would sit continually in the shadow of death. Great industrial activities of modern times, efforts to colonize and to reclaim for civilization vast tropical regions, the immense undertaking to construct the Panama Canal, are all in the first instance dependent upon the successful application to sanitary problems of knowledge, much of it gained in recent years, concerning the causation and propagation of epidemic diseases.

And yet probably a fair measure of the general realization of these facts is the provision by Congress that of the seven members of the Isthmian Canal Commission four shall be engineers, without a word concerning a sanitarian on the commission. There could hardly be a more impressive opportunity to demonstrate to the world the practical value of our new knowledge concerning the mode of conveyance of malaria and yellow fever, the two great scourges of Panama, than that afforded by the digging of the Isthmian Canal. The sanitary problem is not surpassed in difficulty by the engineering problem, but we may feel reasonable assurance that with the sanitary control in hands as trained and capable as those of Colonel Gorgas the ghastly experience of the old French Panama Canal Company will not be repeated.

To comprehend fully the degree and the character of the progress of modern medicine requires a kind of knowledge and a breadth of vision not possessed by the average

man. He is concerned mainly with the prompt relief of his own ailments or those of his family. Of the triumphs of preventive medicine he knows little or nothing. With such dull matters as the decline in the death rate by one half and the increase in the expectation of life by ten or twelve years during the last century he does not concern himself. He takes no account of the many perils which have been removed from his pathway since his birth, and indeed at the time of his birth, nor does he know that had he lived a little over a century ago and survived these perils, he would probably be marked with smallpox.

While it is true that in the relief of physical suffering and in the treatment of disease and accident the progress has been great and the physician and the surgeon can do more, far more to-day than was possible to his predecessors, and while improvement in this direction must always be a chief aim of medicine, still it is in the prevention of disease that the most brilliant advances have been made. The one line of progress, that with which the daily work of the physician is concerned, affects the individual, the unit; the other, like all the greater movements in evolution, affects the race. It has been argued, with a certain measure of plausibility, that the interference with the law of the survival of the fittest, assumed to be a result of the success of preventive medicine, will bring about deterioration of the race. I believe the argument to be fallacious, and that we already have sufficient experience to show that there need be no serious apprehension of such a result.

Before some accurate knowledge of the causation of infectious diseases was secured, preventive medicine was a blundering science, not, however, without its one great victory of vaccination against smallpox, whereby one of the greatest scourges of mankind can be controlled and could be eradicated, if the measure were universally and efficiently

applied. The establishment upon a firm foundation of the germ doctrine of infectious diseases, the discovery of the parasitic organisms of many of these diseases, the determination by experiment of the mode of spread of certain others, and the experimental studies of infection and immunity, have transformed the face of modern medicine. The recognition, the forecasting, the comprehension of the symptoms and lesions, the treatment of a large number of infectious diseases, have all been illuminated and furthered, but the boon of supreme import to the human race has been the lesson that these diseases are preventable.

Typhus fever, once widespread, and of all diseases the most dependent upon filth and overcrowding, has fled to obscure, unsanitary corners of the world before the face of modern sanitation.

In consequence of the knowledge gained by Robert Koch and his co-workers, Asiatic cholera, to the modern world the great representative of a devastating epidemic, will never again pursue its periodical, pandemic journey around the world, even should it make a start.

Of bubonic plague, the most dreaded of all pestilences, which disappeared mysteriously from the civilized world over two centuries ago, we know the germ and the manner of propagation, and, although it has ravaged India for the last ten years with appalling severity, it can be and has been arrested in its spread when suitable measures of prevention are promptly applied.

Typhoid fever, the most important index of the general sanitary conditions of towns and cities, has been made practically to disappear from a number of cities where it formerly prevailed. That this disease is still so prevalent in many rural and urban districts of this country, is due to a disgraceful neglect of well-known measures of sanitation.

To Major Walter Reed and his colleagues of the army

commission, this country and our neighbors to the south owe an inestimable debt of gratitude for the discovery of the mode of conveyance of yellow fever by a species of mosquito. On the basis of this knowledge the disease, which has long been such a menace to lives and commercial interests in our southern states, has been eradicated from Cuba, and can be controlled elsewhere.

Another army surgeon, Major Ross, acting upon the suggestion of Sir Patrick Manson, had previously demonstrated a similar mode of incubation and transportation of the parasite of malaria, discovered by Laveran, and it is now possible to attack intelligently and in many localities, as has already been proven, with good promise of success, the serious problem of checking or even eradicating a disease which renders many parts of the world almost uninhabitable by the Caucasian race and, even where less severe, hinders, as does no other disease, the intellectual and industrial activities of the inhabitants. It is gratifying that one of our countrymen and a member of the board of directors of this Institute, Dr. Theobald Smith, by his investigations of Texas cattle fever, led the way in the discovery of the propagation of this class of disease through an insect host.

The deepest impress which has been made upon the average death rate of cities has been in the reduction of infant mortality through a better understanding of its causes. The Rockefeller Institute, by the investigations which it has supported of the questions of clean milk and of the causes of the summer diarrhœas of infants, has already made important contributions to this subject, which have borne good fruit in this city and elsewhere.

No outcome of the modern science of bacteriology has made a more profound impression upon the medical profession and the public, or comes into closer relation to medical practice than Behring's discovery of the treatment of diph-

theria by antitoxic serum, whereby in the last twelve years the mortality from this disease has been reduced to nearly one-fifth of the former rate.

The most stupendous task to which the medical profession has ever put its hands is the crusade against tuberculosis, whose preëminence as the leading cause of death in all communities is already threatened. Sufficient knowledge of the causation and mode of spread of this disease has been gained within the last quarter of a century to bring within the possible bounds of realization the hopes of even the most enthusiastic, but it will require a long time, much patience and a combination of all the forces of society, medical, legislative, educational, philanthropic, sociological, to attain this goal.

Time forbids further rehearsal, even in this meager and fragmentary fashion, of the victories of preventive medicine. Enough has been said to make clear that man's power over disease has been greatly increased in these latter days. But great and rapid as the progress has been, it is small in comparison with what remains to be done. The new fields which have been opened have been explored only in relatively small part. There still remain important infectious diseases whose secrets have not been unlocked. Even with some whose causative agents are known, notably pneumonia and other acute respiratory affections, and epidemic meningitis, very little has yet been achieved by way of prevention. The domain of artificial immunity and of the treatment of infections by specific sera and vaccines, so auspiciously opened by Pasteur and by Behring, is still full of difficult problems, the solution of which may be of immense service in the warfare against disease. Of the cause of cancer and other malignant tumors nothing is known, although many workers with considerable resources at their disposal are engaged in its study. With the change

in the incidence of disease, due at least in large part to the repression of the infections of early life, increased importance attaches to the study of the circulatory, renal and nervous diseases of later life, of whose underlying causes we are very imperfectly informed. There are and will arise medical problems enough of supreme importance to inspire workers for generations to come and to make demands upon all available resources.

In directing attention, as I have done, to some of the practical results of scientific discovery in medicine, and in indicating certain of the important problems awaiting solution, there is always the danger of giving to those unfamiliar with the methods and history of such discovery a false impression of the way in which progress in scientific knowledge has been secured and is to be expected. The final victory is rarely the result of an immediate and direct onslaught upon the position ultimately secured. The advance has been by many and devious and gradual steps, leading often, it might appear, in quite different directions, and mounted more frequently than not to secure a wider prospect, but without any thought of the final goal. The army contains a multitude of recruits drawn from the most various fields, the biologist, the chemist, the physiologist contributing their share to medical triumphs just as truly as the pathologist, the bacteriologist, the hygienist, the clinician. The inspiration has been the search for truth and joy in the search far more than any utilitarian motive. In the fullness of time comes the great achievement; the leader is hailed, but he stands upon the shoulders of a multitude of predecessors whose contributions to the result are often lost from view.

In full recognition of the dependence of success in the warfare with disease upon increase of knowledge, the Rockefeller Institute for Medical Research was founded by the

enlightend munificence of Mr. John D. Rockefeller, to whom we make grateful acknowledgment. Likewise to the broad sympathies and active interest of his son, Mr. John D. Rockefeller, Jr., the origin and development of this institution are largely indebted.

What has already been accomplished, as well as the general scope and aims of the Institute, have just been concisely indicated to you by Dr. Holt. My purpose has been to show, although of necessity most inadequately, that these aims relate to matters of the highest significance to human society, that the present state of medical science and art requires large resources for its advancement, and that the returns in benefits to mankind have been and will continue to be great out of all proportion to the money expended.

May the hopes of the founder and of those who have planned this Institute be abundantly fulfilled! May it contribute largely to the advancement of knowledge, and may the streams of knowledge which flow from it be 'for the healing of the nations!'

SCIENTIFIC RESEARCH AND MATERIAL PROGRESS.

By NICHOLAS MURRAY BUTLER,
President of Columbia University.

It seems to me significant that this home of scientific research is placed amid the teeming population of a great city. Science has for its end service, and there will be no quicker or more useful application of the discoveries made here than among the tens of thousands who live just outside these walls.

In no way has knowledge more completely revealed its power than in the triumphs of modern engineering and of modern medicine. Engineering and medicine have conspired to make human life pleasanter and happier, and to relieve it from a large amount of suffering and pain. The transmission of energy over long distances and in new forms and the discoveries of the modern pathologists have changed the conditions and even the aspect of life more than we realize.

These buildings are dedicated to the relief of human disease and human suffering by the application of scientific method to the study of a concrete body of facts. They will exert their influence in three ways: they will add to the sum total of human knowledge in respect to medicine; they will aid in developing a company of trained scientific observers; and they will help spread abroad in the public mind a respect for science and for scientific method. Each of these services is a public service, but the last named is perhaps the greatest.

Pasteur, whose name will often be spoken here and

always with reverence, understood this. In 1870, when his country was crushed under overwhelming disaster and staggering under blow upon blow, he found voice to say that neglect of science and of scientific research was a powerful cause of the moral and the military humiliation of France. Said Pasteur:

"France has done nothing to keep up, to propagate and to develop the progress of science in our country. . . . She has lived on her past, thinking herself great by the scientific discoveries to which she owed her material prosperity, but not perceiving that she was imprudently allowing the sources of those discoveries to become dry. . . . While Germany was multiplying her universities, establishing between them the most salutary emulations, bestowing honors and consideration on the masters and doctors, creating vast laboratories amply supplied with the most perfect instruments, France enervated by revolutions, ever seeking vainly for the best form of government, was giving but careless attention to her establishments for higher education."

Each year shows more clearly how true this view is, and how fully it applies to the triumphs both of peace and of war. Japan has even more profoundly impressed the world by her knowledge of scientific fact and by her rigid application of that knowledge than by the valor and military skill of her soldiers and sailors. No people are more in need than our own of learning the all-important lesson that the modern Germans and the modern Japanese have to teach. Respect for the man who knows and loyalty to demonstrated truth are characteristics of civilization that is founded on rock. Our American happy-go-lucky, wasteful way of approaching a serious problem, our naïve egotism and our exaltation of the man who does things, no matter how, must sooner or later give way to more patient study, to more respect for the experience and wisdom of other

countries than our own, and to more regard for correctness and sound principle, than for a superficial costly 'efficiency,' if we are to hold the place in the world's esteem for which we are rightfully ambitious.

This institution is to be welcomed, then, not alone for what it will do for medicine, and not alone for what it will do indirectly for the relief of suffering human beings. It is to be welcomed still more for the lessons it will teach to our public opinion; for the guidance it will offer toward a juster appreciation of the relations between theory and practice, between observation and reasoning; and for the assurance it affords that generous support is to be had in this dear country of ours from men of affairs for research of the highest and most severe type.

Of the subjects with which the Institute is to deal, when we reflect upon their variety, their far-reaching importance and their manifold relationships, can we say less than Faraday once wrote to Tyndall:

"Our subjects are so glorious that to work at them rejoices and encourages the feeblest, delights and enchants the strongest."

THE QUALITIES OF THE SCIENTIFIC INVESTIGATOR.

By CHARLES WILLIAM ELIOT,
President of Harvard University.

The educated public needs to obtain a clearer idea than it now has of scientific research, of its objects and results, and of the character and capacity of the men who devote themselves to it. The educated classes have a tolerably accurate conception of research in such subjects as history including antiquities, economics, philology, law, and government; for research in these subjects relates chiefly to the past, remote or near. The public has also been long interested in the inventor's resourceful and persevering habit of mind—the inventor who is trying to make some new application of acquired knowledge, or to discover a new fact or principle which can be put to commercial use. But scientific research is somewhat different from these other kinds of research. It has deep roots in the past; but its object is never to demonstrate merely what has been done or said, or to obtain a monopolistic profit. Invariably its object is to extend the boundaries of knowledge, and to win new power over nature. It is not chiefly concerned to enlarge records of the past, or to make them more accurate, but rather to use all the powers the past has conferred on the human spirit to win new power. The past gives the scientific investigator his lever and the present his fulcrum; but his work is to take effect on the future, and is to give him or his successors a stronger lever and a better placed fulcrum. As a rule, scientific research is carried on with no public observation, and as silently as nature elaborates

and throws out the mantling verdure of spring; but on an exceptional occasion like this, and in a country which has already reaped great benefits from the endowments of institutions of education and charity by public-spirited persons, it is fitting that the beneficent work of the scientific investigator should be accurately described, and commended to the favor of an enlightened public opinion.

Let us first consider what mental habits and powers the scientific investigator needs to have acquired and to keep in exercise, or in other words what sort of a mind the investigator ought to have. In the first place, he needs the faculty and the habit of determining and grasping facts, and then verifying and digesting them. He must next be capable of conceiving hypotheses which will connect his facts, or explanations that will group them or arrange them in a series. These hypotheses or explanations will come to him as results of reflection or of imaginative scheming; in the common phrase, ideas will occur to him. A preconceived idea may be a great power in experimental researches; but the inquirer must have the habit of pursuing to verification or disproof all such ideas. He must test them by new experiments contrived for that purpose. He must exhaust all the adverse hypotheses which come to his mind. He must always keep in the road that leads to truth, although he does not know just where the truth lies. If through the play of his imagination he gets off the right road, his rigorous experimentation must bring him back to the safe path of the inductive method. He must possess patience and reserve, but also enthusiasm and a capacity for eager speculation. Science has often profited by a suggestive theory, which was far from being true. Indeed, the history of scientific progress is full of these profitable theories, which have been abandoned one after the other; and in all probability the series of such theories will

prove to be infinite. Sometimes theories long forgotten are taken up again after the defeat of the later theories which caused the forgetting of the earlier. However it may be in theology, it is quite certain that in science there is as yet no such thing as final truth. Accordingly investigators in any science need an unusual perspicacity or clear-sightedness in regard to its theories; they need, each in his own field, a full knowledge of the work already done, and a clear perception of the bearings of the most recent discoveries. This perspicacity is in some measure a natural gift; but it is also a faculty capable of a high degree of training. It sees clearly the approximate truth already discovered, and goes forward to obtain a closer approximation.

The general features of scientific research are similar in all fields, although each kind has its peculiar difficulties. The field of the individual inquirer need not necessarily be wide; although the progress of many sciences is often contributory to the progress of one, and that investigator has a great advantage who is capable of seeing clearly the bearings of new discoveries in kindred sciences on the particular inquiry he has in hand. It is all-important, however, in all fields, that the investigator should be capable of seizing on the essential parts of the inquiry, that is, on its causative elements, rather than on those parts which relate to identification, classification, and nomenclature. The pioneers of science, like the pioneers in exploration and colonization, must find their way through pathless regions. It is only later generations that build smooth roads and railways for the transportation of inattentive multitudes where the pioneer trod alone and watchful. The investigator must be watchful over minor details and for apparently insignificant differences and similitudes. He must know how to find his clues in trifling circumstances and illusive changes of condition. In these days of germs and spores,

when microorganisms have been proved to be infinitely important in the economy of nature, the investigator, and especially the biologist, will probably have a peculiar conception of the great and the small, or the gross and the minute. The infinitely little may often seem to him of the highest importance, his scale of values having no connection with spacial magnitude or gravity. On the other hand, the investigator must be keen to discern relationships among facts—first among facts easily classed as kindred, but then among facts which to the common mind are unconnected or disconnected. The intellectual tastes of the true investigator will usually include a liking for the elucidation of mysteries and a liking for new and adventurous problems. These tastes are manifested by men whose walks of life and objects of interest are very different; but they are not common tastes, any more than the faculties needed in such inquiries are common. The scientific investigator wins pleasure or satisfaction where most men and women would find only vexation and futile effort. He finds fascinating what most men and women would find repellant.

After a new discovery has been made, another and quite different task awaits the successful investigator. He desires and needs to procure the acceptance of his discovery by the learned world, and in some cases by the commercial world. This is a process different from the process of discovery, and yet kindred. It involves demonstrations; but these demonstrations require a somewhat different sort of imagining and contriving from that which led to the discovery. The discovery was made in private; the demonstrations must be public. The discovery needed solitary reflection; to procure the acceptance of the discovery needs a power of public exposition, accompanied by debate and even controversy. The discovery required indomitable patience and energy in pursuing and verifying in rapid suc-

cession the conceptions or fancies of genius; the demonstration requires skill in discussion, courage in accepting public tests, and in taking responsibility for risking the property or lives of others.

The history of scientific research amply illustrates the stimulating value of controversy, and the contribution which free discussion makes to real progress. Freedom of thought and speech promotes progress towards truth in science just as effectively as it does the gradual attainment of truth and justice in government, industries, and social structure. Time frequently shows that both sides were measurably right in honest scientific controversies, although one side win a temporary or even an ultimate victory.

The conditions under which research is necessarily performed deprive the investigators of the stimulus which numbers of students give to popular teachers. The laboratories of research contain but few students; and those few are for the most part silent and absorbed. Nevertheless, the younger investigators have two great satisfactions in their work: they follow leaders with hearty enthusisasm and loyalty, and the generous ones among them also maintain a stimulating comradeship with contemporaries in the same fields. Their number is very small in all the contemporaneous fields of inquiry put together; but it is on this small number that the real progress of any nation in the arts and sciences, and, therefore, in civilization and happiness, ultimately depends. Their Herculean labors are self-imposed, and they must set their own standards of excellence; for society can not supply men capable of supervising, regulating, or stimulating them. The ordinary grades of public instruction can be supervised and disciplined; but the scientific investigator must be a law unto himself. The utmost that governments or universities can do for him is

to provide suitable facilities and conditions for his work, and to watch for results.

Among the numerous varieties of scientific research such as chemical, physical, physiographical, astronomical, and biological, medical research occupies a peculiar place. While it avails itself to the utmost of all the exact weighings and measurings of the other natural sciences, it is forced to deal with innumerable materials and conditions which are complicated and made obscure by vital forces. It has to deal with objects which are alive and with processes of organic growth or change. Its evidence can not always be exact; its experiments must often be complicated and obscured by vital reactions; and its results of highest value are often incapable of complete demonstration in the mathematical, physical or chemical sense; because dense shades of ignorance darken the environs of the practical result. Thus, preventive measures against a familiar and definite disease may succeed, while the promoting cause of the disease remains unknown, and the method of its transmission from one victim to another is but imperfectly understood. Vaccination succeeded when the cause or promoting condition of smallpox was unknown. The microbe of rabies is unknown, and yet protective inoculation against rabies has been invented and successfully applied. The mere mention of some of the contributory inventions and discoveries of the past fifty years, such as the principle of fermentation, artificial culture solutions, gelatine plate cultures, selective cultivation, the variety of sterilization conditions for different organic substances, staining technique, immunity through the use of a toxic organism that can be cultivated, increasing or diminishing at pleasure the virulence of a toxic organism, and testing toxins and vaccines on living animals, will readily satisfy even a sceptical mind that medical research has great difficulties of its own to encounter

in addition to the usual difficulty of scientific inquiry in general. Biological research is, therefore, more arduous than physical, chemical, or other inorganic research, because vital processes are difficult to observe accurately, and all the conditions of experimentation are harder to control. The medical investigator must often fish in troubled waters; and sometimes he can not find again the promising fishing ground he has once visited, because unexpected fog prevents him from seeing the intersecting bearings of his desired ground.

Again, medical research habitually strives to arrive at something beyond abstract truth. It seeks to promote public and private safety and happiness, and the material welfare of society. Its devotees have in mind the discovery of means of remedying misery or warding off calamity; and they also know that whatever contributes to health and longevity in any community or nation contributes to its industrial prosperity; so that they are justified in hoping for results from their work which will promote human welfare. In short, medical research is research in science which is both pure and applied. Some genuine scientists affect to despise applied science; and certainly it is not discreditable to men of science that they are apt to value discoveries which have no popular quality or commercial utility more highly than those which immediately attract the favor of the multitude by their industrial effects, or by their striking novelty combined with intelligibility; but all scientists recognize the fact that medical research is directly related to the largest material interests of the community, such as manufacturing, transportion, sanitation, and the methods of providing light, heat, and shelter, and of defending the community against frauds in foods, drinks, and drugs. Many of its problems are economic as well as medical, and require in those who study them sound judgment

in money matters as well as knowledge of natural law, and skill in scientific methods of inquiry. Medical research, therefore, requires in its devotees a combination of theoretical power with practical power—a capacity for both abstract science and applied science. This combination is rare but by no means unattainable. Indeed, abstruse speculation is almost always attractive to masters of the experimental method. The investigator absolutely needs a powerful imagination; but this imagination must be checked by the most rigorous experimentation.

In spite of the fact that medical research involves the suffering and death of many of the lower animals used for purposes of study, the work of medical research is in reality the most humane work now done in the world; for its secondary objects are to prevent disease in men and animals; to defeat the foes of life, to prevent the industrial losses due to sickness and untimely death among men and domestic animals, and to lessen the anxieties, terrors and actual calamities which impair or crush out human happiness. The primary object in medical research, as indeed in all research, is the ascertaining of truth; but these secondary objects are ever before the mind of the investigator, and through them come his greatest satisfactions. These satisfactions ought to be shared by men who, like the founder of this Institute, promote medical research by the exercise of their sound judgment and good will and by their money.

The achievements of medical research since Jenner have been marvelous. Seeing what has been done within a century to diminish the mental and bodily sufferings of mankind from smallpox, diphtheria, rabies, tuberculosis, malaria, yellow fever, puerperal fever and typhoid fever, and to give surgery safe access to every part of the body, we may reasonably believe that equal triumphs, and even greater, await it in the future. May we not hope that

America will contribute her full share to the progress of scientific research, finding no obstacle, but rather means of furtherance, in her democratic institutions? May not we democrats find encouragement in the humble origin of Franklin, Faraday, and Pasteur, and in the contributions democratic America has already made to anesthesia, surgery, the improvement of public water supplies, and the control of Texas fever, malaria, puerpural fever, and yellow fever? May we not reasonably expect our country to produce many men like Louis Pasteur's father, a private soldier of the first empire and a hard-working tanner? In the dedication of his best book the great son said to his father: "The efforts I have devoted to these investigations and their predecssors are the fruit of thy example and thy counsel." Let American parents take that sentence to heart! And let all Americans reflect on another utterance of this greatest of contributors to medical science, this ardent patriot, this independent and indomitable worker, this genuine democrat—Pasteur: "The true democracy is that which permits each individual to put forth his maximum of effort."

PLATE I. SECTION OF THE GENERAL LIBRARY AND READING ROOM.

PLATE II. GENERAL CHEMICAL LABORATORY.

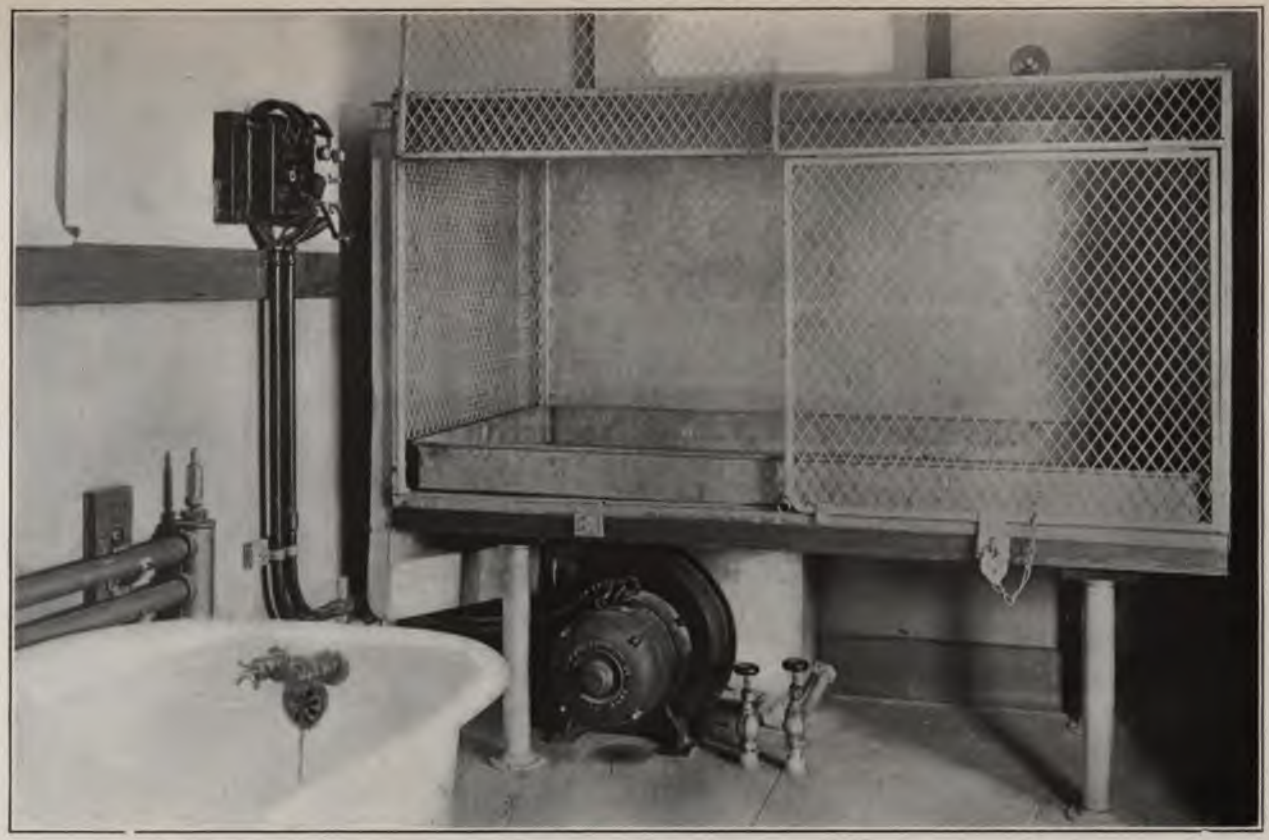


PLATE III. DRYING CAGE FOR ANIMALS.

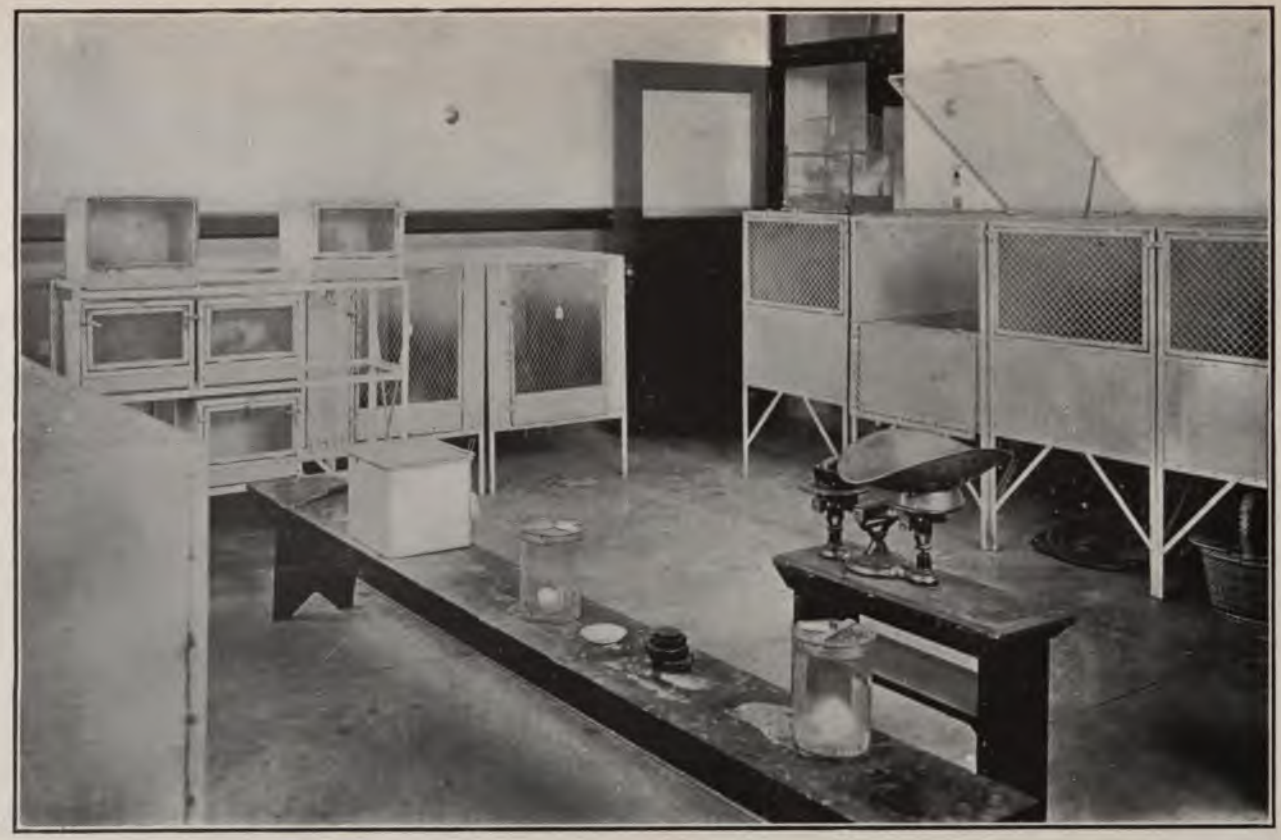


PLATE IV. ANIMAL HOSPITAL.

PLATE V. SECTION OF DIRECTOR'S LABORATORY AND STUDY.

PLATE VII. GENERAL PHOTOGRAPHIC ROOM.

PLATE VII. GENERAL PHOTOGRAPHIC ROOM.

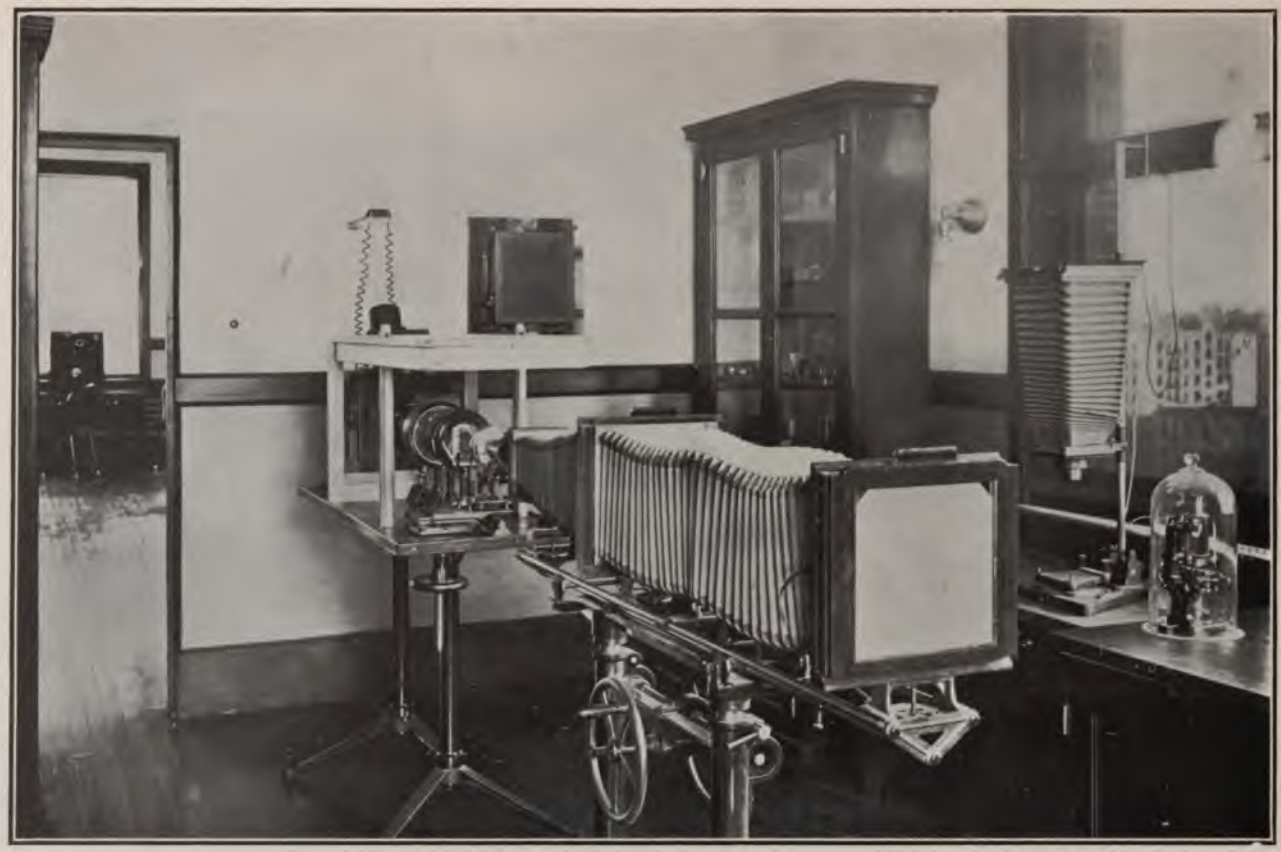
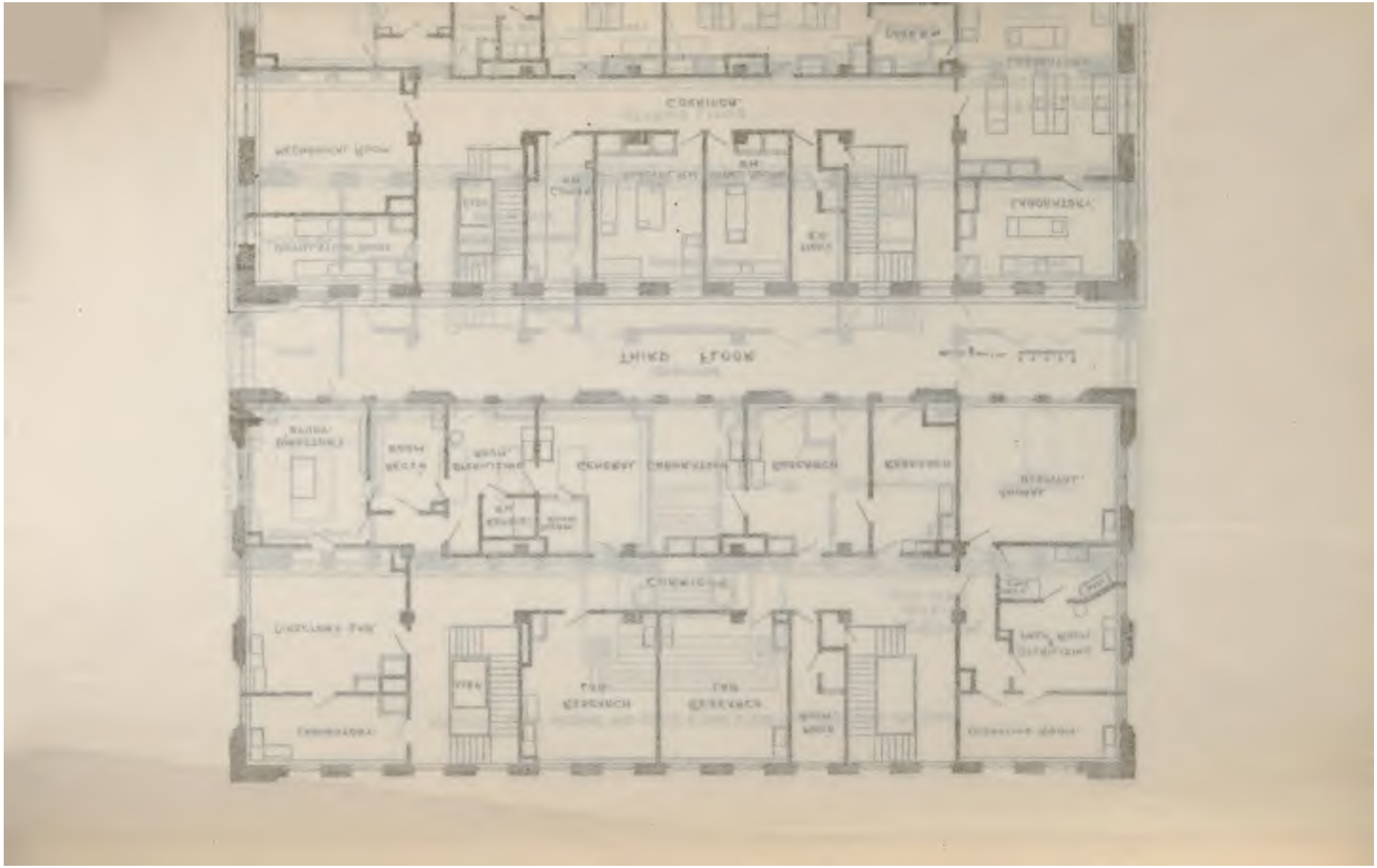
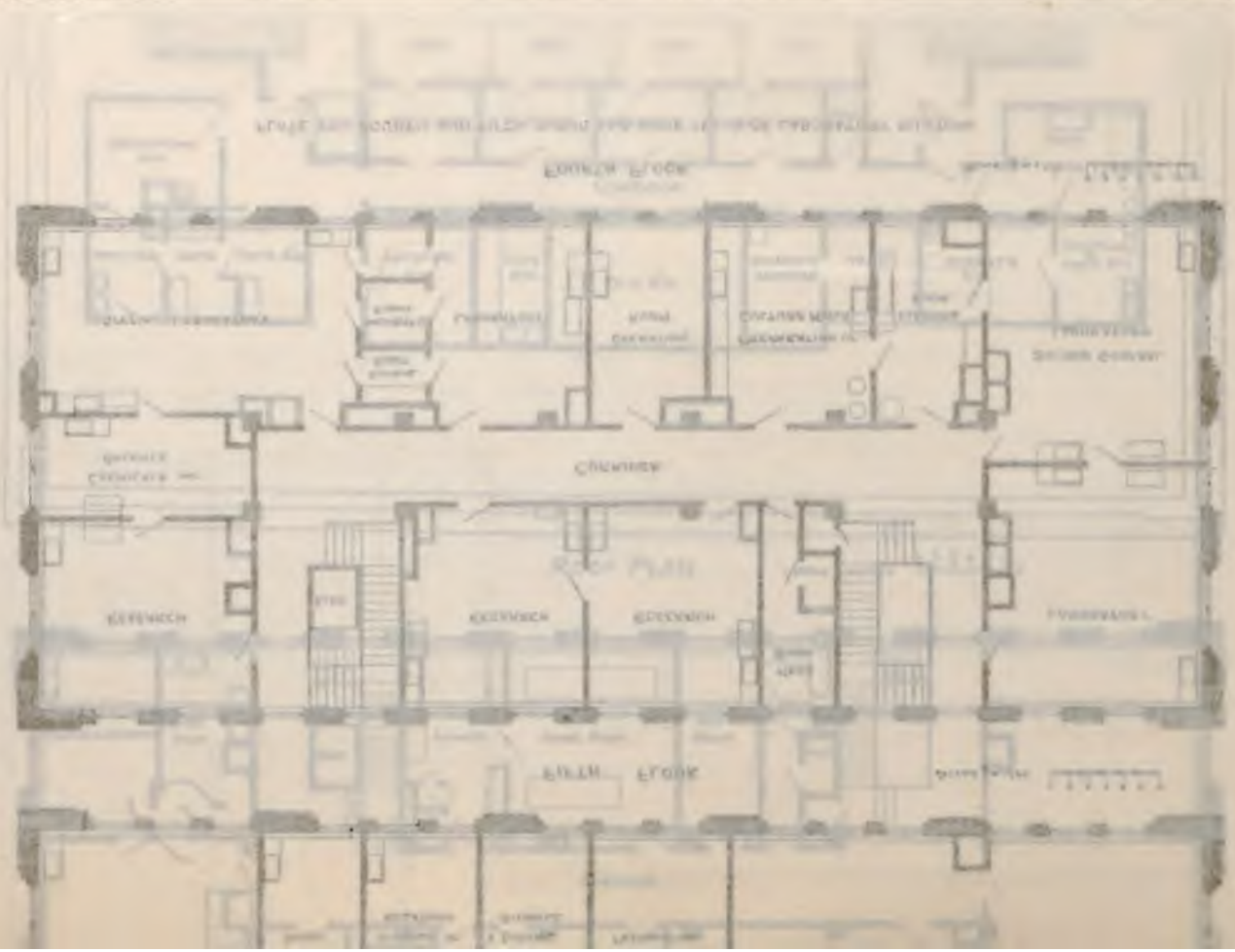


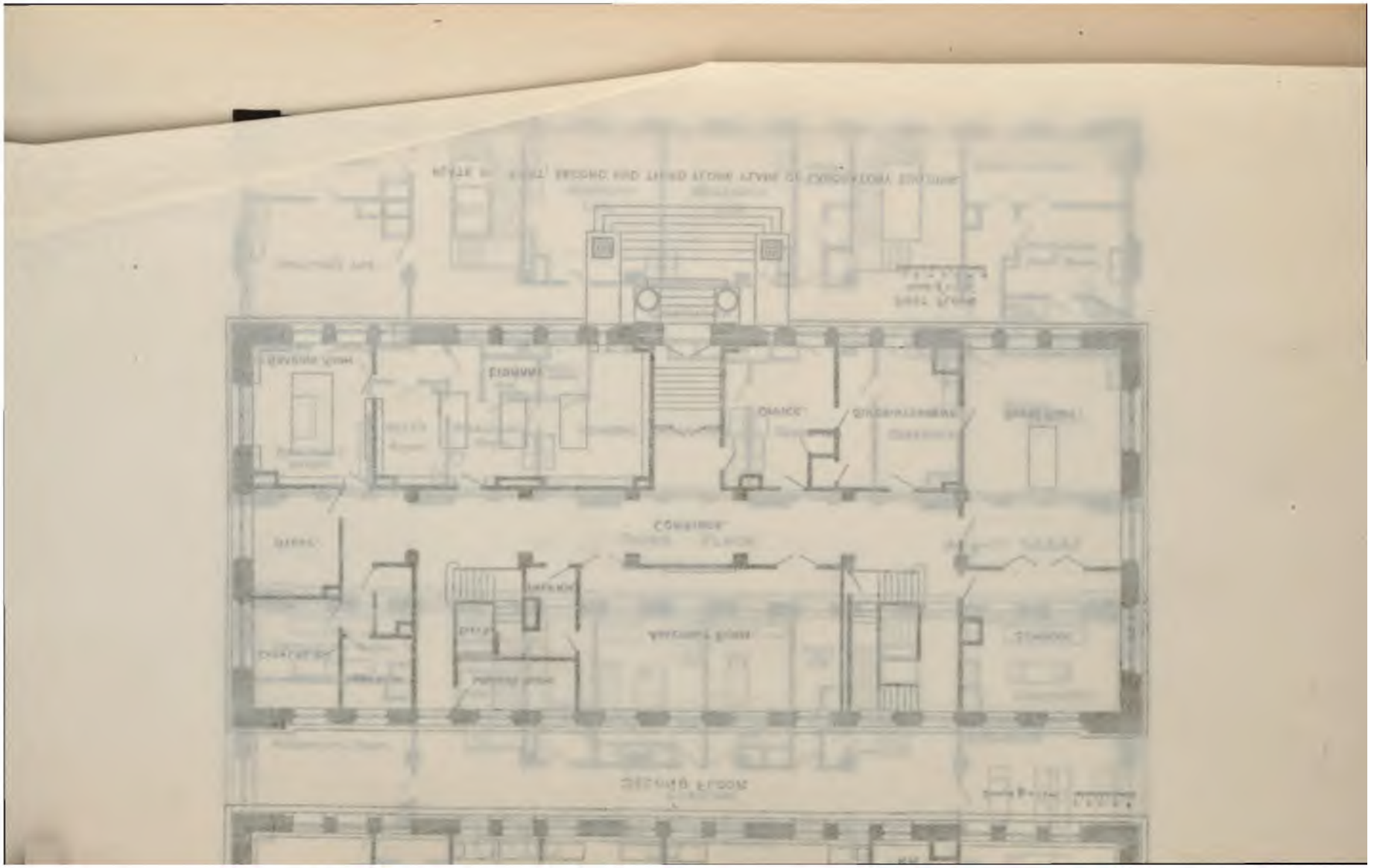
PLATE VIII. MICROPHOTOGRAPHIC ROOM.

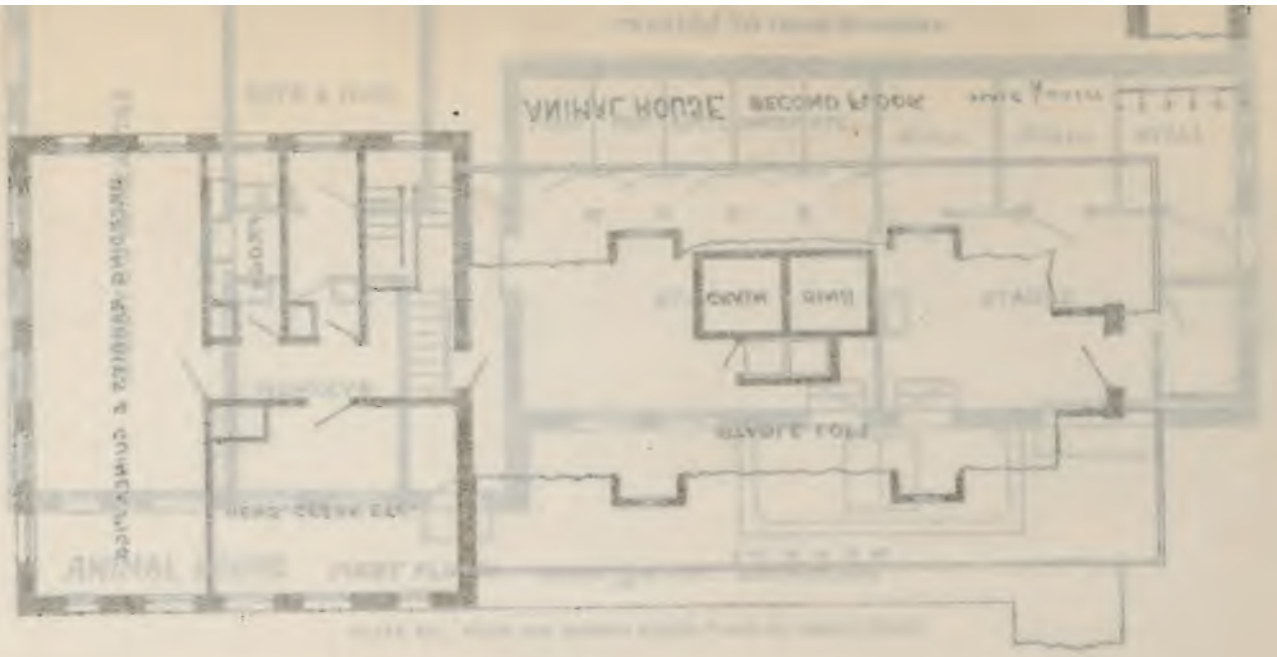
PLATE IX. SPECIAL OPERATING ROOM ON ROOF.

PLATE X. ANIMAL HOUSE AND COVERED WAY TO LABORATORY BUILDING.









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